

Redescription of Two Holostichid Species of Genus *Holosticha* Wrzesniewski 1877 (Ciliophora, Hypotrichida, Holostichidae) from Seoul, Korea

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한국산 전열하모충 속 하모류 2종(유모 문, 하모 목, 전열하모 과)의 재기재

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적 요

서울대학교 관악캠퍼스의 이끼로 덮힌 토양에서 채집된 하모류가 *Holosticha multistylata* Kahl, 1928(多口棘毛全列下毛蟲)와 *H. sylvatica* Foissner, 1982(森林全列下毛蟲)로 밝혀져서 재기재하였다. 기재는 서식처에서 채집된 표본과 배양된 것을 생체로 관찰하고 protargol로 염색하여 섬모하부구조를 관찰한 자료를 통계처리하여 실시하였다. 이 두 종은 한국에서 처음으로 기록되는 종으로 아래의 식별형질로 구분된다. 다구극모전열하모충은 4개의 전방극모, 3개의 구극모와 3개의 등쪽섬모열을 가지는 반면 삼립전열하모충은 7-8개의 전방극모, 1개의 구극모와 5개의 등쪽섬모열을 가진다.

Key words: Systematics, Hypotrichida, *Holosticha multistylata*, *H. sylvatica*, Redescription, Infraciliature, Biometry, Korea

INTRODUCTION

The holostichid hypotrichs are frequently encountered in diverse habitats of environments. Recently, many new genera and species of soil hypotrichs have been discovered and their ecological significance has been affirmed (Berger & Foissner, 1989; Foissner, 1982, 1987). The hypotrichs collected from the moss-covered soils in the campus of Seoul National University, Korea were identified as the species of the genus *Holosticha* Wrzesniewski 1877. However the recognition of species in the genus *Holosticha* is difficult due to the wide variation in cortical patterns. The present paper is concerned with the redescription of the two species of *Holosticha* which are unknown from Korea, comparison with some other related species and biometrical characterization of the species.

MATERIALS AND METHODS

The specimens were collected from the moss-covered soils in the campus of Seoul National University, Korea on September 10, 1992 and June 6, 1993. Laboratory cultures were maintained in a commercial mineral water provided with boiled wheat grain and shrimp meats for supplying fungal and bacterial nutrients for hypotrichs.

The shapes of the live specimens on slides were drawn without covering with cover slips. The infraciliature was observed by using the modified protargol method (Shin & Kim, 1993; Wilbert, 1975). The drawings of the impregnated specimens were made with the aid of a drawing tube. All counts and measurements were undertaken at the magnifications of X400-X1600. Biometrical analysis was performed using the methods described in Sokal and Rohlf (1973). We adopted the classification schemes established by Borror (1972) and Corliss (1979).

RESULTS

- Phylum Ciliophora Doflein, 1901 有毛 門
Class Polyhymenophora Jankowski, 1967 多膜 綱
Order Hypotrichida Stein, 1859 下毛 目
Family Holostichidae Fauré-Fremiet, 1961 全列下毛 科 (신칭)
Genus *Holosticha* Wrzesniewski 1877 全列下毛蟲 屬 (신칭)

1. *Holosticha multistylata* Kahl, 1928 多口棘毛全列下毛蟲 (신칭)(Fig. 1, Table 1)

Holosticha multistylata Kahl, 1928 (p. 212 cited from Foissner & Foissner, 1988); Buitkamp, 1977 (pp. 269-270, fig. 13); Foissner, 1982 (pp. 50-51, fig. 7a-d, table 9); Hemberger, 1982 (pp. 97-102, figs. 15a-i); Borror & Wicklow, 1983 (p. 114, figs. 16, 24, 25, table 1); Dragesco & Dragesco-Kernéis, 1986 (pp. 448-449, fig. 131E, table 20); Foissner *et al.*, 1991 (pp. 236-239, figs. 1-14)

Holosticha (Keronopsis) multistylata: Kahl, 1932 [pp. 574-575, fig. 104 (2)]

Material examined. Ten living specimens and 14 protargol impregnated specimens were observed and analyzed biometrically and their data were summarized in Table 1.

Description. General morphology and behavior: Body soft and flexible, elongate and slender, flattened dorso-ventrally, ranging from 130-190 μm long and 35-70 μm wide *in vivo*; anterior and posterior ends slightly narrowed and rounded; ventral surface flattened and slightly concave; dorsal surface convex; left and right margin of body parallel. Movement rapid and its direction changing frequently.

Frontal and buccal fields: Four frontal cirri (FC) large and prominent, located at ventral surface of right anterior part; two frontoterminal cirri (FTC) located at ventral surface near right anterior margin; approximately three buccal cirrus (BC) slightly prominent, located along paroral membrane. Adoral zone of membranelles (AZM) 43-71 μm long with 26-38 prominent adoral membranelles (AM), covering approximately 42% of body length. Buccal field deep, comprising undulating membrane (UM) of 35-60 μm long. Pharyngeal fibers (PF) at base of buccal field extending to near right margin of body and 22-30 μm long.

Somatic infraciliature: Two ventral cirri (VC) located near transverse cirri (TC); posterior region of ventral surface bearing approximately seven J like TC, and each TC prominent and extending beyond posterior end of body. Left and right midventral cirri (LMVC and RMVC) paired, and

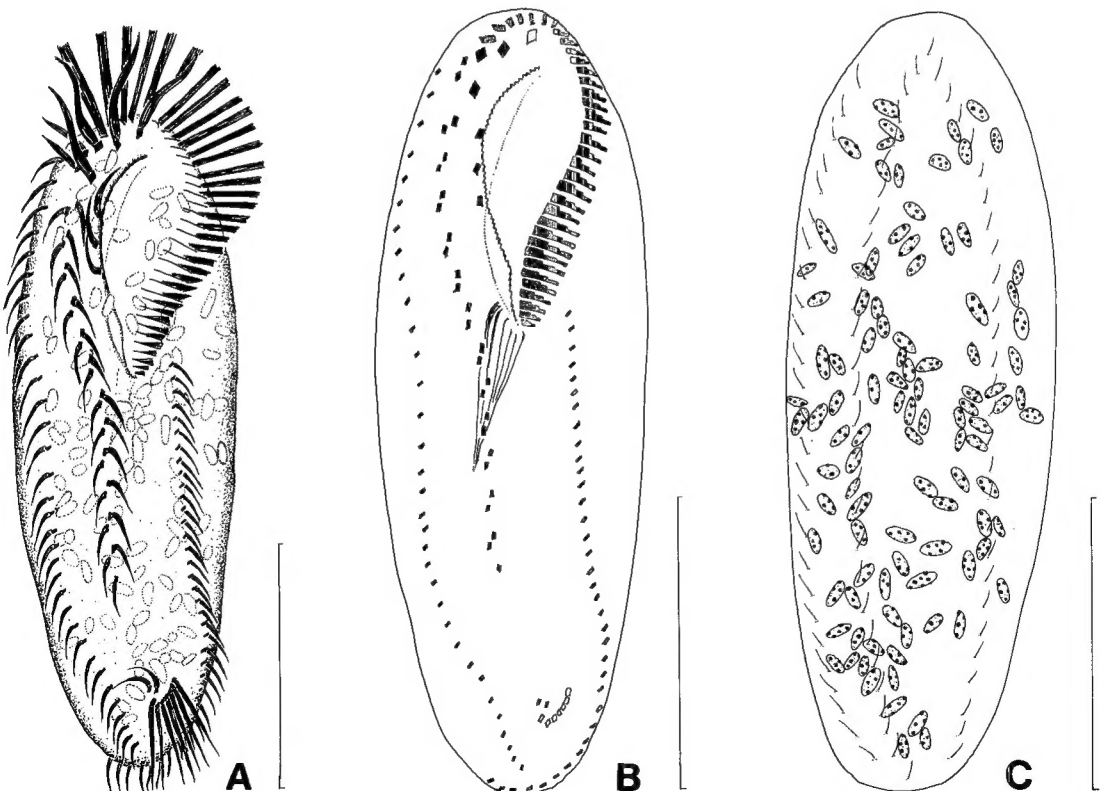


Fig. 1. *Holosticha multistylata* Kahl, 1928: A, living specimen, ventral view. B, infraciliature after protargol impregnation, ventral view. C, dorsal kineties and nuclear state, dorsal view (scale bars = 50 μm).

midventral cirral rows extending to posterior half of body. Left marginal cirri (LMC) and right marginal cirri (RMC) rows extending to posterior end and confluent posteriorly; LMC beginning at region beneath 5th-8th AM, extending right posterior end and bearing 31-41 cirri; RMC beginning near most anterior frontoterminal cirri and bearing 30-38 cirri; number of LMC more than RMC by three. Dorsal surface bearing three dorsal kineties (DK); mid-dorsal kinety with 20-30 cilia; cilia on dorsal surface bristle-like, approximately 5 μm long, some of them more or less shortened.

Nuclear organelles with 78-135 ellipsoidal macronuclei (Ma), 5-6.5 μm long and 2-2.5 μm wide. Contractile vacuole spherical or spindle-like, positioning near middle of left margin of body.

2. *Holosticha sylvatica* Foissner, 1982 森林全列下毛蟲 (신칭)(Fig. 2, Table 1)

Holosticha sylvatica Foissner, 1982 (pp. 58-61, fig. 11a-e, table 12); Borror & Wicklow, 1983 (pp. 105-106, 114, 122, fig. 5, table 1); Berger & Foissner, 1989 (pp. 21-23, figs. 5-8, table 2)

Material examined. 15 living specimens and 19 protargol impregnated specimens were observed and analyzed biometrically and their data were summarized in Table 1.

Description. General morphology and behavior: Body soft and flexible, elongate or long oval in shape, flattened dorso-ventrally, ranging from 150-240 μm long and 50-100 μm wide *in vivo*; anterior and posterior ends slightly narrowed and rounded; ventral surface flattened and slightly concave; dorsal surface convex; anterior part of left margin of body slightly curved inward. Movement rapid and its direction changing frequently.

Frontal and buccal fields: Frontal cirri (FC), including cirri behind left frontal cirri, approximately seven, large and prominent, located at ventral surface of anterior part; two frontoterminal cirri (FTC) located at ventral surface near right anterior margin; one buccal cirrus (BC) slightly prominent, located at mid-point of paroral membrane. Adoral zone of membranelles (AZM) 52-86 μm long with 38-55 prominent adoral membranelles (AM), covering approximately 36% of body length. Buccal field deep, comprising undulating membrane (UM) of 32-49 μm long. Pharyngeal fibers (PF) at base of buccal field extending to near right margin of body and 27-37 μm long.

Somatic infraciliature: Two ventral cirri (VC) located near transverse cirri (TC); posterior region of ventral surface bearing 6-11 J like TC and each TC extending beyond posterior end of body. Left and right midventral cirri (LMVC and RMVC) paired and midventral cirral rows extending to near posterior half of body. Five caudal cirri (CC) located on dorsal surface of right posterior end between right marginal cirri (RMC) and left marginal cirri (LMC). Left marginal cirral row extending almost to right posterior end, and both marginal cirral rows not confluent posteriorly; RMC beginning near most anterior frontoterminal cirri and bearing 34-60 cirri; LMC beginning at region beneath 8th-12th AM and bearing 33-51 cirri; number of RMC more than LMC by five. Dorsal surface bearing five dorsal kineties (DK); mid-dorsal kinety with 20-30 cilia; cilia on dorsal surface bristle-like, approximately 5 μm long, some of them more or less shortened.

Nuclear organelles with approximately 61 oval macronuclei (Ma), 7-11 μm long and 3.5-4 μm wide; 2-5 micronuclei (Mi) spherical, approximately 3 μm in diameter. Contractile vacuole spindle-formed, positioning near middle of left margin of body, during diastole with anterior and posterior channels.

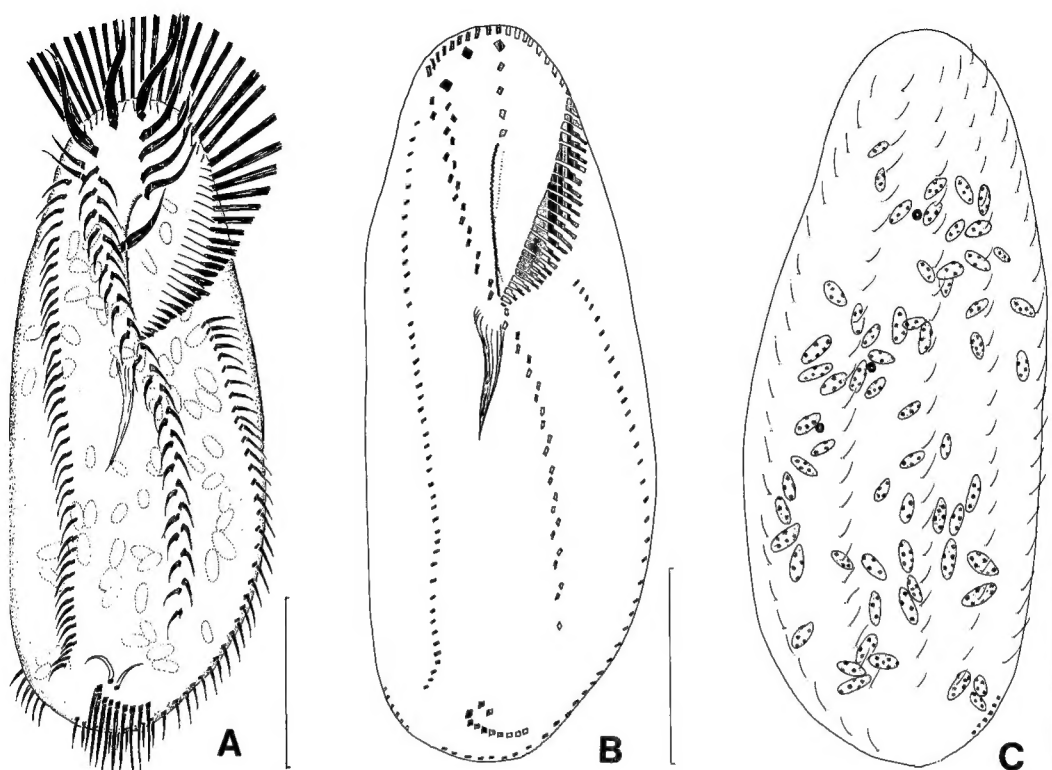


Fig. 2. *Holosticha sylvatica* Foissner, 1982: A, living specimen, ventral view. B, infraciliature after protargol impregnation, ventral view. C, dorsal kineties and nuclear state, dorsal view (scale bars = 50 μ m).

DISCUSSION

***Holosticha multistylata*:** The present species is very similar to *H. adami* Foissner, 1982 and *H. muscorum* (Kahl, 1932) with respect to the shapes of body and adoral zone of membranelles, bearing numerous fragments of macronuclei, and patterns of midventral cirri. The present species can be distinguished from one of the above two species by the following characteristics. (1) The present species has approximately 102 macronuclei, while *H. adami* 80 and *H. muscorum* 200, respectively. (2) The present species has approximately seven transverse cirri, while *H. adami* 6 and *H. muscorum* 12, respectively. (3) The present species possesses confluent marginal cirri, while the *H. adami* not confluent. (4) The present species has approximately three buccal cirri, while the *H. muscorum* seven. (5) The present species has relatively short midventral cirri, while the *H. muscorum* long midventral cirri extending near the transverse cirri (Borror & Wicklow, 1983; Buitkamp, 1977; Dragesco & Dragesco-Kernéis, 1986; Foissner, 1982; Foissner *et al.*, 1991; Hemberger, 1982; Kahl, 1932).

The characteristics of Korean population of this species are slightly different from those of European population. Especially, Korean population has distinctly higher number of somatic cirri

Table 1. Biometrical characterization of *Holosticha multistylata* (upper line) and *H. sylvatica* (lower line). All data were based on protargol impregnated specimens. The abbreviations in the table are the same as in the description except statistical terms (Max.: maximum; Min.: minimum; SD: standard deviation; SE: standard error; CV: coefficient of variation in %; n: population size).

Characters	Mean	Median	Max.	Min.	SD	SE	CV (%)	n
Body length	132.07	124	181	108	25.30	6.67	19.15	14
	184.37	183	227	140	22.71	5.21	12.32	19
Body width	55.86	57	78	33	12.25	3.27	21.94	14
	79.26	85	100	55	14.33	3.29	18.08	19
Body length/width	2.42	2.35	3.33	1.80	0.44	0.12	18.08	14
	2.36	2.35	2.75	1.98	0.25	0.06	10.80	19
AZM length	56.00	56	71	43	8.66	2.31	15.46	14
	65.89	61	86	52	9.76	2.24	14.82	19
Body/AZM length	2.36	2.39	2.78	2.00	0.28	0.08	11.89	14
	2.81	2.83	3.15	2.48	0.18	0.04	6.35	19
UM length	46.93	47.5	60	35	7.04	1.88	15.01	14
	40.53	40	49	32	4.81	1.10	11.87	19
UM/AZM length	0.84	0.84	0.90	0.80	0.04	0.01	4.53	14
	0.62	0.63	0.67	0.57	0.03	0.01	4.58	19
PF length	25.89	25	30	22	3.22	1.07	12.43	9
	31.25	31	37	27	2.63	0.76	8.43	12
Ma length	5.50	5	6.5	5	0.68	0.19	12.31	13
	8.47	8	11	7	0.84	0.19	9.93	19
Ma width	2.04	2	2.5	2	0.14	0.04	6.80	13
	3.89	4	4	3.5	0.21	0.05	5.38	19
Mi diameter	—	—	—	—	—	—	—	—
	2.89	3	3	2.5	0.21	0.05	7.23	19
Ma number	102.73	106	135	78	18.82	5.67	18.32	11
	61.65	60	88	52	8.40	2.04	13.63	17
Mi number	—	—	—	—	—	—	—	—
	3.20	3	5	2	0.77	0.20	24.21	15
DK number	3.00	3	3	3	0.00	0.00	0.00	11
	5.00	5	5	5	0.00	0.00	0.00	14
AM number	32.43	32	38	26	3.59	0.96	11.07	14
	46.74	46	55	38	4.84	1.11	10.36	19
BC number	2.89	3	3	2	0.33	0.11	11.54	9
	1.00	1	1	1	0.00	0.00	0.00	16
FC number	4.00	4	4	4	0.00	0.00	0.00	14
	7.42	7	8	6	0.61	0.14	8.18	19
FTC number	2.00	2	2	2	0.00	0.00	0.00	12
	2.00	2	2	2	0.00	0.00	0.00	18

Table 1. Continued

Characters	Mean	Median	Max.	Min.	SD	SE	CV (%)	n
LMVC number	10.78	11	11	10	0.44	0.15	4.09	9
	16.60	16	21	14	2.29	0.59	13.81	15
RMVC number	12.56	12	14	12	0.73	0.24	5.79	9
	17.71	17	21	15	2.09	0.56	11.81	14
VC number near TC	1.83	2	2	1	0.39	0.11	21.23	12
	1.89	2	3	1	0.47	0.11	24.96	18
TC number	6.92	7	8	6	0.79	0.23	11.46	12
	8.50	8.5	11	6	1.41	0.35	16.64	16
CC number	—	—	—	—	—	—	—	—
	5.31	5	8	3	1.65	0.46	31.13	13
LMC number	36.11	36	41	31	3.98	1.33	11.03	9
	40.31	40	51	33	6.21	1.72	15.41	13
RMC number	33.60	35	38	30	2.88	0.91	8.56	10
	45.77	47	60	34	7.83	2.17	17.11	13

(both marginal and midventral cirri) and larger body size (Foissner *et al.*, 1991). As a part of the biometrical data (Table 1), we calculated the coefficients of variation (CV). The following characters showed the CV of 0.00: the numbers of dorsal kinety, frontal cirri and frontoterminal cirri. Thus these characters are found to be very constant and therefore considered as important diagnostic features of this genus. Comparatively low CVs ranging from 4.09 to 11.54 were shown in the following characters: numbers of adoral membranelles, buccal cirri, transverse cirri, both marginal and midventral cirri, UM/AZM length and macronucleus width. These characters are very important for identification of species because of their low variability. Other characters showed fairly high value of CV ranging from 11.89 to 21.94.

***Holosticha sylvatica*:** The present species is most related to *H. tetracirrata* Buitkamp & Wilbert, 1974 with respect to the shapes of body and adoral zone of membranelles, numerous fragments of macronuclei, and patterns of midventral cirri. The present species can be distinguished from *H. tetracirrata* by bearing the following characteristics. (1) Frontal cirri approximately seven, three in *H. tetracirrata*. (2) Dorsal kineties five, four in *H. tetracirrata*. (3) Possession of ventral cirri near transverse cirri, absent in *H. tetracirrata*. (4) Transverse cirri approximately eight, three in *H. tetracirrata* (Berger & Foissner, 1989; Buitkamp & Wilbert, 1974; Foissner, 1982).

The characteristics of Korean population of this species are slightly different from those of European type and Japanese populations. Especially, the Korean population has distinctly higher number of macronuclear segments [average 60 in Korean population; European type population 32; Japanese population 56], adoral membranelles [46; 35; 44], right marginal cirri [45; 32; 42] and left marginal cirri [40; 31; 37], pairs of midventral cirri [17; 13; 17], cirri behind the left frontal cirri [4; 2; 4] and caudal cirri [5; 2; 4] (Berger & Foissner, 1989; Foissner, 1982). As a part of the biometrical data (Table 1), we calculated the coefficients of variation (CV). The following characters showed the CV of 0.00: The numbers of dorsal kinety, buccal cirri and frontoterminal cirri. Thus these characters

are found to be very constant and thus considered as important diagnostic features of this genus. Comparatively low CVs ranging from 4.58 to 10.80 were shown in the following characters: The numbers of adoral membranelles and frontal cirri, body length/width, body length/AZM length, UM/AZM length, length or width of macronucleus, micronucleus and pharyngeal fiber. These characters are very important for identification of species because of their low variability. Other characters showed fairly high value of CV ranging from 11.81 to 31.13.

ABSTRACT

The soil hypotrichs collected from the moss-covered soils in the campus of Seoul National University were identified as *Holosticha multistylata* Kahl, 1928 and *H. sylvatica* Foissner, 1982. These two species are discovered for the first time from Korea and redescribed with illustrations. The description was based on the observation of living specimens, protargol impregnated specimens and biometric analysis. They are distinguished from congeneric species by their following characteristics : 4 frontal cirri in *H. multistylata* and 7-8 in *H. sylvatica*, 3 buccal cirri in *H. multistylata* and 1 in *H. sylvatica*, 3 dorsal kineties in *H. multistylata* and 5 in *H. sylvatica*.

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